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U.S. MINERALS DEPENDENCE ON SOUTH AFRICA

A REPORT

TO THE

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FOREWORD

The dependence of the United States and other Western industrial countries on South African minerals is an issue which seems to surface each time there is an American election or there are new signs of unrest within South Africa or on its borders. In order to provide the Committee with more complete information on the implications for United States policy of this dependency, two Committee staff members, Joel Johnson and Gerald E. Connolly, visited South Africa in August of 1981. They circulated a private report for Committee Members upon their return. Given recent reports of labor unrest in South African gold mines, and renewed activity on both the diplomatic and military fronts regarding Namibia, I believe the report would be useful for the public. I have therefore asked the staff to update the report for publication.

The report includes several important observations:

—Western industrial states are much more dependent on South African minerals exports, in the sense that there are few alternative sources for chrome, vanadium, manganese and platinum, than South Africa is on the West for export earnings from those minerals. Most of South Africa's export earnings come from gold, a high value, low volume commodity which would easily be smuggled out of South Africa and which would have a ready market throughout the world—particularly in Third World countries. Hence any multilateral, across-the-board embargo of imports from South Africa is both politically unlikely and would have little prospect of being an effective method of forcing internal change.

—The notion that in an international crisis the Soviets might interdict minerals shipments from South Africa is unlikely except under such wartime conditions where shipping from the Persian Gulf would also come under attack. In that case the immediate loss of petroleum supplies to the West would far exceed in importance the longer term loss of minerals for industrial purposes. Factories and war machines would stop from lack of fuel before they suffered from lack of chrome.

—It is possible, but unlikely, that political upheavals in South Africa would lead to a disruption of minerals shipments to the West for foreign policy reasons. Experience with most developing countries is that their requirements for foreign exchange to meet broadened social demands on their budgets means that they are willing to ship almost any commodity to any buyer. Examples include Angola, Cuba, and Allende's Chile. In all cases these countries have exported to the West. The greatest risk from a leftist regime is not over foreign policy issues, but rather changes in domestic policies which would result in decreased minerals production (because of flight of capital and skilled labor and management).

—The most likely scenario for cutoffs of minerals from South Africa would involve domestic social unrest and possible violence which could reduce production or eliminate it for brief periods of time. Such violence could come from frustrated black labor, because of continuing apartheid policies, or from disgruntled white labor which could feel threatened if the pace of social change increases.

These tentative conclusions in turn suggest several policy options which the United States might pursue:

—In order to protect the economy from short to medium interruptions in supply of critical minerals from South Africa, legislation might be considered to allow for a modest increase in current stockpiles, with provisions allowing release of such stocks to nondefense industries in the case of temporary nonmarket-related supply disruptions.

—A renewed effort might be made in the Organization for Economic Cooperation and Development (OECD) to devise a common stockpile policy. The United States might put force behind such a proposal by declaring that if no cooperative schemes are in place, export controls would be imposed on U.S. supplies in an emergency situation.

—Standby legislation might be considered to ease certain Federal regulations such as emission controls requirements on new cars (catalytic converters account for over half of annual U.S. platinum consumption) for short periods of time.

—Some deferral tax incentives or subsidies might be provided to encourage firms to maintain certain uneconomic minerals processing facilities in mothballs, so that the United States could quickly gear up to process ores from other source countries if imports of processed metals (ferrochrome, ferromanganese) from South Africa were disrupted.

—Continued pressures must be exerted on South Africa to move away from apartheid. More importantly, no encouragement should be given to white South African hard liners that the United States will ignore social injustice for strategic reasons. On the other hand, there is much evidence that one of the strongest pressures on South Africa to moderate its policies is the strain on a growing economy caused by the limited pool of skilled white and black labor, which requires accelerated training and absorption of blacks. This calls into question the advisability of encouraging limits on foreign investment in South Africa. Finally, the United States should continue to do what it can to help educate black South Africans—both inside and outside the country—so that there will be a large pool of Western trained blacks. Education is one area (employment and politics are others) in which the United States should promote meaningful change leading to the rightful participation by blacks in the country's managerial and decisionmaking processes.

There is no question that South Africa is strategically important to the United States and the Western world, and that its unique endowment of certain minerals is a major reason for that importance. There is also no question that sooner or later profound change will come to that country. It is to be hoped that the process will be rapid and peaceful. But if it is not, the West needs to be prepared to deal with the side effects of such change—not by trying to hold back change itself, but by making advance preparations to ensure that our own economies can continue to function without major disruption. I would hope this report will help stimulate discussion on the nature such advance preparations might take. The views contained in the report reflect those of the staff members and do not necessarily reflect the views or opinions of the Committee on Foreign Relations or any of its Members.

CHARLES H. PERCY,
Chairman.

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EXECUTIVE SUMMARY

U.S. dependence on imports of certain critical minerals has received considerable attention in recent months. Our heavy reliance on South Africa for the import of chrome (and ferrochrome), platinum, and manganese minerals which are essential for specialty steels and petroleum refining has been publicly linked by the Reagan Administration to a policy of improved relations with the Government of South Africa, and to increased preoccupation with Soviet and Cuban involvement in neighboring Southern African states.

Several scenarios could lead to short-term or lengthy disruptions of strategic mineral supplies from South Africa. Five scenarios are reviewed in this study, listed in order of increasing probability of occurrence:

—Direct Soviet control or interference
—Takeover by a Marxist-oriented government
—International boycott against South African exports
—South African embargoes on selected mineral exports
—Disruptions related to internal instability

Soviet disruption of minerals transport from South Africa was judged likely only in the context of widescale conflict in which petroleum supplies from the Persian Gulf would also be disrupted, which would be a more serious problem than the loss of minerals themselves. Even a takeover of South Africa by a black Marxist-leaning government at some time in the distant future was not deemed a major risk to our minerals supplies. There are no significant examples of Third World Marxist states withholding raw materials from world or U.S. markets for foreign policy reasons. Marxist states usually seek to enhance their accumulation of foreign currency to pursue their internal social objectives. The greater risk is related to domestic policies pursued by a Marxist state which disrupt investment and efficient operation of industries (and encourage flight of capital and trained professionals).

The Organization for Economic Cooperation and Development (OECD) dependency on South African minerals makes a general economic boycott against South Africa (and its apartheid policy) most unlikely. There is a greater possibility that South Africa, if confronted with a variety of selective sanctions which it felt jeopardized its survival, might embargo certain mineral exports to put pressures on the industrial West. This study notes that South Africa derives 60 percent of its export revenue from gold and diamonds—commodities which would likely increase in price if South Africa suspended exports of the critical minerals covered in the study.

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Possible social upheaval within South Africa itself in the next decade might well involve labor unrest in the mines and processing facilities; sabotage and terrorism could focus on industrial and transport targets, and general uncertainty within the white community could lead to emigration of trained experts as has recently occurred in Zimbabwe. The more intransigent the white minority government, and the more disillusioned the black majority population with the prospect of peaceful reform, the more likely the possibility of such disruptions.

Considerations for specific policy options involve two major categories—improved capacity to deal with short and medium term disruptions in minerals supplies from South Africa, and policies which might prevent such disruption in the first place. Steps to improve our capacity to deal with disruptions include:

—Legislation to allow for some increase in stocks of critical minerals, and for release of such stocks to nondefense industries in the case of temporary nonmarket-related supply disruptions.

—An effort to encourage joint stockpile planning with other OECD countries of these critical minerals, backed by a clear statement of intent to use export controls if necessary if other countries have not cooperated in helping to prepare for an emergency.

—Standby legislation to ease certain regulations such as emission control requirements on new cars (catalytic converters use over 50 percent of annual U.S. platinum consumption and 2 percent of chrome consumption) for short periods of time, perhaps combined with government adjustment assistance for civilian companies temporarily knocked out of production by such suspensions.

—Review of Federal policies to remove prohibitions or to increase incentives for production and/or processing of these minerals. Some form of tax incentive or an outright Federal subsidy might be considered to keep obsolete processing facilities in working condition, so that in an emergency where U.S. supplies of processed minerals from South Africa (e.g., ferrochrome) are disrupted, the United States would rapidly be able to increase the domestic processing capacity of crude ores from stockpiles or alternative foreign sources.

In terms of long term foreign policy regarding South Africa, the report suggests continued efforts to seek a settlement in Namibia and the economic progress of Zimbabwe, and correct but not close relations with the current Government of South Africa. Programs to train black South Africans—in the United States, elsewhere in the Western world, and even in South Africa—should all be the subjects of possible increased U.S. funding.

I. Introduction

In recent years several reports, including two generated by the Congress, called attention to the dependence of the United States on imports of several strategic minerals from the southern African region. The question of our dependence, and of Soviet activities in southern Africa, was also discussed during the 1980 Presidential campaign. Former Secretary of State Alexander M. Haig, Jr., who referred to a "Third World resource battleground," argued that this dependency was an important variable which must be considered in designing our foreign policy regarding the southern Africa region in general and South Africa in particular.

Our staff visit to South Africa was intended to address the following questions:

—What kind of scenarios might be envisioned which could result in a disruption of supplies of strategic minerals from South Africa?

—What is the likelihood of each scenario occurring?

—Are there policy measures which the United States as a prudent consumer ought to take to guard against potential disruptions or their effects?

During the course of our stay in South Africa, we met with representatives of the Chamber of Mines, leading United States and South African mining companies, the Zimbabwe Trade Commission, the Bureau of Minerals, the South African Railroads, and officials at the U.S. Consulate General in Johannesburg and the Embassy in Pretoria. Although time and circumstances did not permit extensive interviews with black leaders, staff did meet with several younger black professionals, attended a brief meeting with Bishop Desmond Tutu, head of the South African Council of Churches, and held discussions—outside South Africa—with representatives of the banned African National Congress (ANC).

II. Minerals Background

South Africa is endowed with an extraordinary diversity of industrially useful mineral deposits, with the notable exception of oil. Its non-fuel minerals industry is the fourth largest in the world, next only to that of the United States, the U.S.S.R. and Canada. Ninety percent of South Africa's mining business is for export markets. South Africa is the world's second largest coal exporter, with a projected 1986 export capacity of 46 million tons of coal each year. Europe is its largest customer, with France dependent on South Africa for half of its total steam coal consumption. Estimates of South Africa's coal reserves run as high as 110 billion tons. In 1981, total export earnings, of which minerals constitute 75 percent, dropped to $20 billion, from a record $26 billion received in 1980. Gold is by far the most important mineral in terms of value, accounting for almost 75 percent of South Africa's mineral exports in 1981. Coal and diamonds each accounted for another five percent or so of total mineral exports.

U.S. DEPENDENCE ON SOUTH AFRICAN SUPPLIES OF FOUR KEY MINERALS

Mineral/alloy	Total imports as percent of U.S. consumption (1980–81 average)	Imports from South Africa	
		Percent of U.S. imports (1980–81)	Percent of U.S. consumption (1980–81)
Chromium:			
Ore	100	47	48
Ferroalloys	85	67	57
Manganese:			
Ore	98	33	33
Ferromanganese	79	[1] 62	[1] 49
Vanadium:			
Pentoxide	5	45	2
Ferroalloys	8	[1] 30	[1] 2
Ores, slags, residues	19	75	14
Platinum: Group metals	151	[2] 66	[2] 101

[1] Includes an estimated amount for ferromanganese imports from France and other countries of ore originating in South Africa.
[2] Includes an estimated amount for imports from Great Britain of platinum-group metals originating in South Africa.

Source: U.S. Bureau of Mines, Minerals Yearbook, 1980 and estimates for 1981.

It is not these minerals, but rather four strategic ones, which enhance South Africa's importance as a major minerals supplier to the West. The Western industrial world depends heavily on South Africa for chrome, manganese, vanadium and platinum. A major disruption in the supply of these minerals would have a disastrous impact on oil refining and the production of a variety of specialty steels needed in such industries as aerospace and machine tools. The above chart provides dramatic evidence of the concentration in South Africa of production and, even more important, of reserves of these minerals.

The United States is almost completely dependent on imports of chromium, manganese, and platinum, either in the form of ore or ferroalloys (see table below). It is particularly dependent on South Africa for imports of chrome and ferrochrome and platinum. United States sources of manganese ore are more diverse, but over 50 percent of our ferromanganese comes directly from South Africa. Even in the case of vanadium, of which the United States is a net exporter, most other industrial countries import nearly all their requirements of that mineral. A disruption in supply by South Africa, which produces about 42 percent of the world's vanadium, would obviously lead to a sharp increase in demand by other countries for U.S. supplies of that mineral.

1981 WORLD MINE PRODUCTION AND RESERVES OF FOUR KEY MINERALS

[In percent]

Mineral	United States	South Africa	Soviet Union [1]	Other
Chromium:				
Production		34.3	37.4	Turkey (4.1), Zimbabwe (5.9), Philippines (6.1), other (12.2).
Reserves		67.6	.6	Zimbabwe (29.7), other (2.1).
Manganese:				
Production		22.8	39.3	Gabon (6.2), India (6.2), Australia (7.6), Brazil (7.9), other (10).
Reserves		40.9	44.7	Australia (6.1), Gabon (3), Brazil (1.8), other (3.5)
Vanadium:				
Production	13.5	30.6	30.6	Chile (14), Finland (6.9), other (4.4).
Reserves	.6	42.2	39.2	China (12.7), Australia (1.9), other (3.4).
Platinum-group metals:				
Production	.1	45.7	47.9	Canada (5.2), other (1.1).
Reserves	1.3	81.2	16.7	Canada (0.8).

[1] The Soviet Union production and reserve percentages for chromium and manganese include production and reserve figures for all the Soviet Bloc countries.

Source: U.S. Bureau of Mines. "Mineral Commodity Summaries," 1982.

The case of chrome and manganese is also interesting in that the United States imports a far higher share of its ferrochrome and ferromanganese alloys from South Africa than of the ores themselves. South Africa has a highly sophisticated minerals processing industry, particularly when compared to developing country minerals producers such as Zambia or Zaire. For a variety of reasons, the U.S. capacity to process various ores is decreasing. A number of old processing facilities did not meet new environmental regulations, and in light of alternative sources, it was uneconomic to retrofit them. Import competition and high investment costs in the United States have made investment in new plants unattractive.

As a result, in the case of ferrochrome, the United States now has only one remaining processing plant, located in South Carolina, with a maximum annual production capacity of 300,000 tons, compared to total U.S. requirements of 700,000 tons a year. Zimbabwe can provide us with chrome ore, but can only produce a total of 100,000 tons of ferrochrome a year (as compared to a 600,000-ton capacity in South Africa). As our capacity to process ore deteriorates, our ability to shift from South African sources of processed minerals to other developing country sources of unprocessed ore will correspondingly decrease.

III. South African Economic Scene

Stimulated by the soaring price of gold, South Africa's economy enjoyed a boom period in 1979–81. This expansion had several important political repercussions. It came at a time when the Botha-wing of the National Party had embarked on a modest relaxation of the "petty apartheid" laws (although the larger apartheid system of racial segregation which has governed the nation since 1948 remained intact). Increased revenue from high gold prices and a generally robust economy allowed the government to budget large increases in services for blacks without cutting into programs for whites. Mineral exports were a major stimulus for the 1979–81 economic "boom" experienced in South Africa, not only because of the foreign exchange they earned for the country, but also because these exports represent a large share of internal capital formation. Foreign investment in South Africa, while about 25 percent of total investment, is no longer as necessary for new growth, given the large domestic base and earnings from exports. Indeed, even during the recent economic boom, South Africa suffered a net outflow of investment capital, a trend which began with the 1976 Soweto riots. However, foreign investment will be essential if South Africa is to maintain the annual 5 percent growth rate it desires (and requires) to deal with political and economic problems.

Additionally, the booming economy increased the strain on the skilled manpower pool, emphasizing to the white business establishment that economic growth could not continue if blacks were not trained and brought into the labor force at an accelerated rate. The liberalizing trend in the government and the need for blacks in the labor force also worked to accelerate increased acceptance of "black" and even mixed unions in South Africa.

While in South Africa, staff met with high officials in the mining industry. Almost without exception, these representatives of the private sector advocated changes in their nation's apartheid system to remove barriers to the free movement of badly needed labor and to expand the pool of skilled manpower. Of the total mining workforce of 710,000 in South Africa, 85 percent is non-white. Representatives of the South African Chamber of Mines, with whom we met, estimated that over the next 5-year period, the mining industry would create an additional 80,000 jobs—virtually all of them to be filled by black Africans. As one industry official stated, "all of the changes in the apartheid system which have come about in recent years have been due to economic, not political, pressures; as our economy continues to grow, the demand for even greater reform will be compelling, if our labor needs are to be met."

Both the economy and the liberalizing trend of the government now seem to be running out of steam, and the price of gold hovers at the $400-per-ounce range, well below the $600–$800 range of the 1979–81 period. Nonetheless, the basic economic fact remains that South Africa cannot have a modern and expanding economy if it excludes 80 percent of its population from skilled jobs and, as a consequence, from the domestic economic market.

IV. Potential for Disruption

There are several scenarios which could result in short-term or lengthy disruptions of strategic mineral supplies from South Africa. In order of increasing probability, staff reviewed the following five scenarios:

—Direct Soviet control or interference;
—Takeover by a Marxist government;
—International boycott against South African exports;
—South African embargoes on selected mineral exports; or
—Disruptions related to internal instability:
  —labor unrest,
  —sabotage and terrorism,
  —major social breakdown.

A. DIRECT SOVIET CONTROL OR INTERFERENCE

A scenario in which the Soviets used direct force in South Africa or elsewhere in southern Africa to cut off minerals production or in which they interdicted shipping from the region would almost certainly take place in the context of much larger hostilities. Such hostilities would almost certainly involve the interruption of other supplies (e.g., oil from the Persian Gulf) which would dwarf in importance the problem of the loss of the four strategic minerals produced in South Africa. Furthermore, such a scenario would involve difficult logistical problems for the Soviet Union in addition to the formidable opposition of the highly sophisticated South African military.

No one with whom we met in South Africa, including United States and South African industry and governmental representatives, considered such a scenario a serious possibility. Several industry representatives noted that in Marxist Mozambique, the South Africans operate the rail network for the export facilities at Maputo, in cooperation with the East German technicians who help manage the port itself. Unilateral Soviet action to cut off mineral exports from southern Africa to the West, weighed against other scenarios for disruption, would seem a highly improbable event in the foreseeable future, on both political and logistical grounds.

Such an unlikely scenario must be addressed in the context of global conflict with the Soviet Union. U.S. policy in the southern African region is only of marginal importance to the broader question of superpower rivalry. Obviously, in considering appropriate strategic stockpiling policy in the event of such a global conflict, particular attention should be paid to the minerals produced in southern Africa, especially platinum and chrome, for which the West's major alternative supplier is the Soviet Union.

B. TAKEOVER BY A MARXIST-ORIENTED GOVERNMENT

Concern has been expressed that there is a shift toward Marxist-oriented governments in southern Africa which could eventually result in a Marxist takeover in South Africa itself. Supplies of strategic minerals from South Africa might then be imperiled for the Western

countries, particularly if a Marxist South African Government were to withhold supplies in concert with the Soviet Union, the other major source of several critical minerals. There are two potential flaws in this analysis which make the scenario less probable than those outlined below.

First, there are not many examples of Marxist successes in the Third World, particularly in countries which have had a lengthy experience with British law and parliamentary systems. The struggle for black-dominated governments in Kenya and Zimbabwe resulted in black governmental institutions which closely paralleled their white predecessors. In particular, the Soviets have had only minimal success in convincing Third World countries to subordinate their foreign policy interests to that of their own. Politically, the Soviets have had a series of reverses in the Third World (e.g., China, Chile, Indonesia, Egypt, Somalia). Cuba remains in the fold, but at a high economic cost to the Soviets.

More importantly, however, there is little evidence that Marxist states will give up the foreign exchange they derive from exports exclusively for foreign policy reasons. The most notable example of an African Marxist state is perhaps Angola, where Cuban troops guard Gulf oil installations in Cabinda Province. Gulf Oil Company representatives have cautioned the U.S. Government on taking any moves which might destabilize the situation there. With Cuban troop protection, Gulf oil flows from Angola to the Western world.

Numerous examples exist of Marxist and Communist nations trading freely with the West by marketing their mineral resources. Allende's Chile never intentionally withheld copper from world markets, and Castro's Cuba would presumably be quite happy to sell nickel to the U.S. market if we were willing to buy. East European countries sell coal and other minerals to the West, and the Soviets are, of course, trying to increase their gas exports to Western Europe. In fact, a troublesome experience with the Soviet Union has sometimes been a tendency to dump large quantities of a particular metal on the market when for some domestic reason, hard currency was needed or internal stocks were too high. The South Africans, in fact, seem to have sought cooperation, if informally, with the Soviets to preclude such market disruptions in the case of gold and diamond sales.

Most developing countries need all the hard currency they can generate. Arguably the sole exception has been with our Arab friends in the Persian Gulf, who have withheld production in order to keep prices up, but with spotty results. The need for hard currency is particularly acute for Third World states which place a high priority on increasing social services and redistributing income to the poor.

While supplier states are unlikely to disrupt sales of raw materials for foreign policy reasons, particularly in order to support a Soviet foreign policy objective which they do not strongly share, their own internal economic and social policies can lead to disruption, and it is this contingency for which the United States might well prepare itself. There is certainly ample experience of such disruption when a government embarks on a policy of expropriation of foreign firms, heavily taxes or otherwise infringes on the liberties of highly skilled technicians, or becomes involved in xenophobic campaigns against foreigners who are important in providing such skilled services.

Of course, it should be noted that such policies and their unintended results are not unique to Marxist-leaning governments. The nationalist takeover of U.S. oil companies in Mexico in the 1930's may well have delayed by several decades the discovery of the true extent of Mexico's oil wealth. In the 1970's, the nationalistic Peruvian generals disrupted the rate of exploitation of Peru's mineral development as did Allende's policies in Chile. A full range of Third World governments has pursued policies which disrupted the exploitation and sales of their raw materials. However, in almost no case was this the result of calculated moves meant to obtain foreign policy objectives. One of the few examples in modern history was a Soviet curtailment of chromite exports initiated during the Korean war and extending from 1950 to 1960. No such actions were taken during the Vietnam war.

In sum, there is little evidence to support the thesis that takeovers by Marxist governments, even of South Africa, are likely to jeopardize the West's supplies of minerals on foreign policy grounds, although disruptions in supplies could occur because of internal domestic policies which such regimes might take. However, that kind of disruption is likely under any scenario in which a black nationalist government emerges in South Africa from a situation of domestic strife, whether Marxist or otherwise.

C. INTERNATIONAL BOYCOTT AGAINST SOUTH AFRICAN EXPORTS

Should the Namibia issue remain unresolved or should South Africa take some new domestic or international action which proved particularly repugnant to the international community, pressure could increase in the United Nations for some new form of sanctions against that country—not unlike the chrome embargo adopted by the U.N. against Rhodesia in the last decade. Sanctions could include a boycott against all South African exports and/or exports to South Africa.

It is most unlikely, however, that such a boycott would actually be agreed to by the major industrial powers. Mineral dependence on South Africa by Europe and Japan is even greater than for the United States. In addition to the four minerals already discussed, our allies depend on South Africa for important shares of their imports of such minerals as coal and uranium.

Nor is it likely that such an across-the-board boycott would be effective if the effort were seen as a means of bringing South Africa to its knees economically. South Africa is self-sufficient in virtually all foodstuffs. South Africa derives around 50 percent of its total export earnings from gold and diamond exports. Its total annual export shipments of these two commodities could fit into eight Boeing 747s, which underscores the difficulty of preventing these goods from entering the world market. Other major South African exports, such as wool, maize, fruit and coal, could presumably be hindered by a boycott, but even these goods would be likely to find markets.

South Africa is dependent on petroleum for about 25 percent of its energy requirements. Currently 80–90 percent of that petroleum must be imported. However, South Africa's ambitious coal-to-oil conversion now allows South Africa to obtain from 10–20 percent of its needs by

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converting domestic coal. By 1985 this share is expected to rise to between 30–50 percent of its total needs. In addition, South Africa has a strategic oil storage program which already covers 1.5–2 years of its imports. While South Africa depended for about 90 percent of its oil requirements on Iran before the revolution, it quickly shifted its sourcing to the spot market. Although no Arab country officially sells petroleum to South Africa, it is believed that most of the spot market oil South Africa obtains comes from the Persian Gulf region. In sum, even the oil lever, if applied through international sanctions, would be unlikely to be very effective.

The main point of this review, however, is the effect a general boycott against South Africa would have on the several minerals for which Western economies are dependent primarily on South Africa and the Soviet Union. During the Unilateral Declaration of Independence (UDI) period in Rhodesia when U.N. sanctions were in effect, much Rhodesian chrome entered the world markets under the guise of South African chrome. In fact, figures recently released by the Government of Zimbabwe indicate that production of chrome did not decrease during the sanctions period, but rather increased from 447,500 tons in 1964 to a peak of almost 900,000 tons in 1976. Easy evasion of sanctions might be more difficult if the subject of the embargo were South Africa. Because an embargo on the four strategic minerals would be difficult to circumvent, Western countries are therefore much less likely to take the step of endorsing an overall embargo. They are certainly unlikely to do so unless they nrst built up adequate stocks or alternative sources of supply for those minerals in advance. There is no sign that the Europeans or Japanese are prepared to take such steps.

D. SOUTH AFRICAN EMBARGOES ON SELECTED MINERAL EXPORTS

South African Government officials have several times suggested that if pressed to the wall by the international community, the country might retaliate by withholding mineral supplies from the world market. Such comments have generally been disclaimed by Prime Minister Botha and are anathema to the private mining companies. Businessmen argue that part of South Africa's attractiveness to foreign buyers is its long record of dependability as a supplier in meeting contracts. A boycott, or even the serious threat of one, would undermine such confidence. Government and business also state that South Africa depends too heavily on revenue from its mineral exports to endanger that income by a boycott. As noted below, however, we believe that the South African economy as a whole would be little affected by a selective embargo on strategic minerals.

Representatives of industry, whom we interviewed, repeatedly dismissed the possibility of a unilateral South African embargo of strategic mineral exports. One official of the Chamber of Mines acknowledged that there has been some government discussion of an embargo, but informed us that industry leaders were unanimously opposed to the idea, or even the discussion of such an idea, fearing that the West might be prompted to look to other suppliers for its mineral imports, or advance its technology to reprocess its minerals, thus recycling in lieu of importing minerals. The chairman of a major mining company referred to official National Party rhetoric of Western depend-

ence and vulnerability to an embargo as "pure tribal drum beating by the hardcore Afrikaners. Business would never cooperate with such a plan."

Industry attitudes toward a unilateral embargo notwithstanding, there is a basis for believing that the idea is not entirely farfetched. Politically, several officials of the ruling National Party have from time to time intimated that they have considered just such an action, and the idea might have a certain appeal to it were South Africa faced with total isolation by the international community, particularly if the economic costs would not be unbearable.

As noted, the industrialized West is heavily dependent on four minerals from South Africa. These are strategically and economically crucial to our economies, but in fact account for only a small portion of South Africa's total export exchange earnings. Indeed, it could be argued that a cutoff by South Africa of one or more of these strategic minerals could increase the country's overall revenue, as the uncertainty created in the importing countries by such a move would likely result in sharply increased gold prices. A return in gold prices to only $500 an ounce from the current price of around $400 an ounce would bring in twice the revenue to South Africa as it receives for all of its exports of chrome, vanadium, platinum and manganese combined. Gold was at the $600-plus level in late 1980.

In sum, the notion of a unilateral South African embargo against certain strategic exports is not farfetched in economic terms. The rest of the world would certainly suffer more than South Africa, at least in the short term. However, it is doubtful that South Africa would take such an action unless it felt extreme provocation, such as a selective embargo on certain exports to South Africa, including petroleum and high-technology machinery. Such a move would certainly undercut whatever support it had left in international commercial circles and be tantamount to a severing of its ties with the West. An embargo might be applauded by more hard-line elements of the Afrikaner community, but would underline to the rest of the white community, the complete isolation of the government and country from the Western world. This kind of ultimate recourse could be made even less likely if Western countries had sufficient stocks of the strategic minerals to make a selective embargo more costly to South Africa, at least in the short run, than to its customers.

One South African official admitted to us that he and his colleagues were "amazed" at the lack of change in U.S. stockpile capabilities. "Given your limited processing capacities in the United States," he asked, "why stockpile chrome and managanese and not ferrochrome and ferromanganese?" Clearly a major review of stockpiles might prove a prudent course for the OECD countries. Such a review ought to include the kinds, as well as the amounts, of minerals to be stockpiled; and, in the case of chrome, assess the chemical, as well as metallurgic uses for such stockpiles in the eventuality of an embargo or temporary disruption of supplies.

E. DISRUPTIONS RELATED TO INTERNAL INSTABILITY

South African society is coming under increasing strain. This strain is already manifested in increasing numbers of strikes, sometimes

aimed at social conditions rather than job-related problems. It is also evident in the increasing number of incidents by terrorist groups, primarily operating under the loose organization of the African National Congress (ANC). And on a few occasions it has taken the form of spontaneous mass outbursts, notably the 1976 Soweto riots. Such labor unrest, terrorist activities or wholesale social breakdown could disrupt the production, processing and transport of strategic minerals in South Africa.

Labor unrest.—As already noted, periods of economic growth, such as that experienced by South Africa in 1979–81, place increased demands on the South African manpower pool which cannot be met by whites alone. It is estimated that there is a current shortfall of 250,000 skilled and professional workers in South Africa. Shortages are reported in all of the professions, including nurses, teachers and mid-level managers in business and industry. As a result, blacks must increasingly be trained and absorbed into skilled jobs. This is especially true of the mining industry. Ironically, this potential for improved standards for those blacks brought into the labor force also increases the potential for labor disruption.

Increased numbers of blacks have meant expansion of black unions and attempted integration of other unions. In a society where blacks are disenfranchised, the trade union provides one of the only places where blacks can organize and leaders can emerge. These labor organizations, as they grow in size and sophistication, are certain to become a powerful outlet for black expression of frustration with myriad aspects of South African society in addition to specific job grievances. There have already been examples of strikes in South Africa where the contested issue was not one of management-labor relations and hence one which management could negotiate and resolve, but rather reflected broader social frustrations.

Furthermore, as black and integrated unions gain strength and blacks move into a wider variety of job categories, hostile reaction from whites and their segregated unions can also be anticipated. For example, several years ago, when one mine attempted to license a black as a blaster in an underground mine (currently a white monopoly, although many blacks are trained in the use of explosives and actually do the work under white supervision), the mine was faced with a wildcat strike by the white blaster's union. The walkout lasted 6 days and was unsuccessful in preventing the hiring of the black blaster.

White or black protest over change or lack of change in job conditions or black labor unrest related to general dissatisfaction with social conditions in South Africa could result in increased strike activity, thus slowing minerals production. Given the overall surplus of black labor, however, it is unlikely such actions will have more than temporary impact on minerals production, which could be largely offset by maintaining slightly larger stocks in South African mine sites and port facilities. Organization of blacks is also made difficult because miners are recruited from many tribal groups within and outside of South Africa who speak many languages. The common mine language—Fanakolo—has a limited vocabulary which makes political discussions difficult.

Such labor unrest might also manifest itself in incidents of industrial sabotage, which so far has not been a major factor in South African mines. Mines do take safety and security precautions, such as maintaining strict control over explosives and using fire resistant wood supports in the mines. In most cases, minerals are produced in a number of geographically dispersed mines, and most large mines are either open-pit or involve complex shafts with multiple entries, making sabotage which would have any long-term effect most difficult. Nonetheless, multimillion-dollar shovels in open-pit operations or ventilating and transport equipment in deep mines could be damaged or destroyed. Once again, however, it is doubtful that such efforts could do more than cause temporary inconvenience or production drops in individual mines and would not necessarily have a long-term impact on South Africa's ability to meet its export commitments.

Sabotage and terrorism.—In addition to labor unrest, minerals production and availability could also be affected by a more intense campaign of sabotage and terrorism in South Africa. To date such actions have been limited. The attack in 1980 on Sasol II—part of South Africa's ambitious coal-to-oil conversion program—even though it only moderately affected oil production, did indicate that economic targets were vulnerable to sabotage. Furthermore, the incident was sufficiently unsettling to South African authorities that the government passed a Critical Points Act in 1981 which requires certain private enterprises to undertake heightened security precautions.

In August 1981, there was an incident in which the lobbing of several rockets into a major military compound outside of Pretoria caused physical damage in a highly-secured military installation less than ten miles from the nation's capital. The fact that guerrillas could conduct such an operation will certainly encourage their colleagues and supporters, while it creates uncertainty among the white population as to the military's ability to maintain internal security.

Such acts can have an impact on the minerals sector in two ways: first, guerrillas might well target highly visible, internationally important sectors of the economy as a means of bringing their plight forcefully to the attention of the Western nations. Thus, South Africa's three platinum beneficiation plants, six ferrochrome smelters, key transport links connecting the mines to the ports, and port loading facilities could all present attractive targets for destruction which would disrupt minerals availability and attract attention overseas.

Second, highly visible terrorist attacks of any sort could well trigger the kind of exodus of trained white professionals which has plagued other African economies undergoing a painful transition from white to black rule. This is likely to happen more slowly in South Africa than other countries, such as Zimbabwe, because the white population is the largest on the continent and because there is not as obvious a place for refugees to go (in the rest of Africa, South Africa has always provided a haven for white refugees). Nonetheless, if the anticipated increase in worldwide demand for minerals takes place in the mid-80s, trained mining engineers will be in demand in Australia, Canada, Latin America and relatively stable (or high-paying) African countries. Any sizable exodus of white technicians would slow down, or at least limit any expansion, of the South African minerals industry and put further pressure on black-white labor relations as more blacks would have to be trained and brought into higher skilled jobs.

Government officials and businessmen in South Africa currently downplay the potential for such physical attacks on mining and transport infrastructure. In private conversations, however, several businessmen did acknowledge that there have been increasing incidents on the South African railway system. Beneficiation plants are already under tight security (particularly in the case of platinum) to protect industrial secrets. Such security, however, is geared more against internal problems than attacks from the outside.

Major social breakdown.—While labor unrest or internal acts of violence could have short-term, disruptive effects on South Africa's ability to maintain a dependable supply of strategic minerals to international customers, a major social upheaval could bring about a long-term interruption or at least a decrease in production. Such a breakdown is not entirely dismissed by U.S. company representatives in South Africa. There have been recent examples of states with a well entrenched upper and middle class, a well outfitted military and efficient secret police, which have experienced revolutionary transformation with rather surprising rapidity. Cuba's sugar harvests after the fall of Batista, Iran's oil production, and Nicaragua's exports of coffee and cotton all plunged after their revolutions.

Unless South Africa proves to be unique in the family of nations and manages to maintain indefinitely a political system legally structured on the basis of race, then change will inevitably come. If that change comes about with violence levels no higher than that previously in Kenya or Zimbabwe, minerals production is likely to continue, albeit with some interruptions and probably with some limits on new expansion. But if, as many seem to anticipate, that change will only come as the result of major upheavals, then the West could find itself forced to deal with sharply reduced supplies of strategic minerals from South Africa for a number of years.

As previously noted, this decrease would be likely regardless of what kind of regime evolved from such turmoil—whether pro- or anti-Western, whether Marxist, socialist or even capitalist. The basic problem will be that uncertainty and violence may result in the departure of skilled white personnel; mining, transport and processing operations consequently will decline in efficiency; and new investment will be slow to materialize. This is by no means a scenario which is unavoidable, or necessarily imminent. But it is one which should at least be built into the planning and policy of the Western industrial states over the next decade.

Politically, South Africa must face some harsh economic facts. Its white skilled labor pool is insufficient to run its modern and expanding economy. The National Party government, in power since 1948, seems intent on preserving the basic tenets of the system of apartheid which, coupled with the controversial homelands policy, is repugnant to the majority black population, and perceived as inefficient and economically counterproductive by the large majority of the white business community. As one industry leader told us, "The government mistakenly believes that it can have economic integration with political separation. It cannot work." Even with a growth rate of GNP reduced to 2 or 3 percent per year over the next 5 years, South Africa's shortage of 250,000 skilled workers can be expected to increase. Meanwhile, 300,000 new workers enter the labor market every year, most of them

unskilled, most of them black. Among blacks, unemployment is estimated to range from 10 to 25 percent. Unless the South African Government is willing to launch a massive and costly drive to train its majority black population, its labor problem promises to become severe over this next decade. Such a task has enormous implications for the minority government of South Africa, which currently spends $761 to educate each white pupil, while budgeting only $75 for each black child. Less than 10 percent of the nation's black teachers have a high-school diploma. And almost half of South Africa's 80 percent majority population is under the age of 16. As one South African told us, "Time may have already run out here. Enfranchisement must come through upgraded education and organized trade unions or it will come at the end of a gun."

V. U.S. Policy Options

The above analysis suggests that a disruption of supplies of critical minerals from South Africa is not probable, but could happen. Such an interruption would most likely be of a relatively short duration (a few weeks to months) and likely be the result of factors beyond the government's control (labor unrest, sabotage, civil unrest). There is a longer-term possibility that supplies could be interrupted for a lengthy period of time because of social upheaval and transition to a majority government. Such an interruption in exports would not likely relate to foreign policy objectives of a government under siege or a new government, regardless of its political proclivities, but rather to internal economic problems and a dearth of professionals and capital.

There are two policy areas suggested by this analysis for the United States to investigate. First, what measures could the United States take to offset the effects of an interruption in our imports of critical minerals from South Africa? Second, are there steps the United States could take to help prevent such an interruption?

A. PREPARATION FOR INTERRUPTIONS

There are at least four possible U.S. actions which might be taken to deal with short- to medium-term interruptions in the shipment of critical minerals from South Africa (or other African countries, for that matter). These include: (1) the use of strategic stockpiles, perhaps modified to include additional stocks specifically provided for economic circumstances; (2) the judicious use of export controls to protect the supplies we do have, including released stocks; (3) standby authority to restrict certain civilian uses of these minerals; and (4) diversifying sources of supply, including increased or at least maintained U.S. production and reprocessing capabilities.

Stockpiles.—The United States already has an extensive stockpiling system to deal with defense emergencies. The stockpile includes supplies for each of the four strategic minerals imported from South Africa. However, in most cases the stocks in actuality do not contain the full amounts of materials provided for under existing targets. And as already noted, at least in the case of chrome, there is some evidence that we should shift our stockpile away from chrome ore to stocks of ferrochrome.

Current law provides that stocks can be released on order of the President for purposes of national defense during a time of war declared by Congress, or a national emergency. The law also states that stocks cannot be released for general economic or budgetary purposes. It is reasonably clear that stocks could be released to a defense industry if supplies were simply not available. This was the case for the last stockpile release in December 1979, when a combination of the embargo against Rhodesia and failure to find a new source in Canada meant that a rare form of long-fiber asbestos simply became unavailable. As a result, the President authorized the release of 1,500 tons of asbestos from the stockpile for the single U.S. company that uses this material for defense-related products.

The kinds of scenarios outlined above, however, would present the United States with a much murkier problem. Some supplies from other sources would be available, even if South African shipments of a particular mineral were disrupted, but market adjustment to shortfalls would likely have a major price impact. If it were determined that the interruption were in all likelihood to be of limited duration, neither the price increases nor permanent changes in industrial practices might be desirable. The ability to release some stocks under those circumstances might assist U.S. industry to get through a temporary problem with minimal adjustment costs.

Current legislation might be modified to provide specifically for temporary non-market-related interruptions in the supply of all or some of the existing strategic stockpiles. Specific limits might be set on the quantity which might be made available for strictly economic emergencies, and stockpile targets might also be increased to cover such specified amounts. Even if an interruption were deemed to be of a long-term or indefinite duration (for example, over 9 months), a limited release from stockpiles might at least give the market more time to adjust at a lesser cost, thus easing potential inflationary effects.

Cooperation and export controls.—The Export Administration Act (Public Law 96–72) allows the President to restrict exports "where necessary to protect the domestic economy from the excessive drain of scarce materials and to reduce the serious inflationary impact of foreign demand." While this provision was basically intended to deal with restrictions on U.S.-produced products, it could also be used to restrict the export of stockpiled goods which had initially been imported. Presumably, if availability of a critical mineral on international markets were sharply curtailed and the United States released its own stocks, it would want to prevent such stocks from being shipped overseas.

However, in the case of some of these critical minerals, there are complex traditional trading patterns. Much of our platinum, for example, is imported from Great Britain, but originates in South Africa. There is two-way trade of a number of these minerals at various levels of processing. It might be useful for the United States, in cooperation with other industrialized countries to prepare some contingency planning for dealing with interruptions in supply of the four minerals we import from South Africa, plus perhaps three or four other minerals which come from similarly restricted sources. Should stocks be part of such planning, the United States should obviously press our allies to maintain stocks similar to our own or to insure that in shortfall periods, the United States would not be

disadvantaged in sharing existing new production because we alone held stocks.

Civilian consumption.—A review might be made of civilian uses of these critical minerals which could be interrupted in the event of a supply disruption with minimal effects on the civilian population and industry. Perhaps the best example is that of the catalytic converter on American automobiles, which accounts for about 50 percent of U.S. platinum consumption and 1 to 2 percent of U.S. chrome consumption. The converter, after all, is installed on automobiles because of Federal and State Government requirements. Such requirements might be temporarily suspended during a shortage period for one or both of these minerals, with perhaps a requirement for retrofitting the converters when the crisis is passed. Adjustment assistance of some sort might be provided to the producers of converters to tide them over the crisis period.

There may well be similar civilian uses of these minerals where temporary restrictions could result in substantial decreases in consumption. Authority for such restrictions (or suspension of current requirements) might be limited to 3 to 6 months, so that the government would not interfere with long-term market adjustments should an interruption prove to be a long-term phenomenon.

Alternative sourcing.—Ideally, the United States should find means of diversifying its source of supply of these key minerals. In the best of all possible worlds, some of those new sources would involve mining in our own territory. Government regulations which prevent mining in the United States, including on national lands, periodically should be reviewed as the international situation may warrant. Programs which encourage U.S. investment in mining in economically attractive sites overseas should also be continued and perhaps enhanced. Legislation extending the Overseas Private Investment Corporation (the U.S. Government's program to insure U.S. investments overseas) included some changes along these lines, and the Administration has expressed an interest in some kind of internationally-sponsored insurance program for overseas investment.

However, given our current knowledge of reserves of these minerals, prospects for economic exploitation outside of the South Africa/Zimbabwe region are not great. The private sector has little motivation to spend its own resources to seek new supplies of the critical minerals under discussion when known resources in South Africa are so large and of such quality. It would not make sense to devise programs involving a large government subsidy (directly or indirectly) to bring about such diversity on an economic basis. A 20 percent subsidy, used instead to increase government stockpiles, would in 2 years allow the establishment of a stockpile equal to 5 months' comsumption—a stockpile which would probably be adequate for most economic contingencies.

Consideration might also be given to government programs which would assure that processing facilities for critical minerals which are no longer economically or environmentally viable are nonetheless preserved in a state where they could be reopened for brief periods. This would provide some additional margin for shifting away from processed minerals from South Africa to unprocessed ores from other countries in a time of emergency. Such a policy might involve some

modest tax writeoffs or even outright subsidy to firms which maintain processing facilities in working conditions.

B. PREVENTION OF DISRUPTION

In addition to preparing for the possibility of a disruption in our supplies from South Africa, the United States should also seek to prevent such a disruption in the first place. While this study primarily focuses on our minerals dependency and does not purport to reflect on the broader range of politics of South Africa nor our overall foreign relations with that country, discussions with white government officials, business leaders, black professionals and dissidents (both inside and outside South Africa) led to some tentative conclusions about U.S. policy.

First, our ability to influence the rate of change in South Africa toward a multiracial society seems to be quite asymmetrical—we can do more to slow the process than to speed it; we can more easily influence the course of events to be violent than to be peaceful. If the United States is perceived to have lowered its interest in pressing for social change in South Africa, as was the widespread impression conveyed in South Africa by its government and the press about the Reagan Administration, this tends to encourage those elements in the white population, primarily among the Afrikaners, who wish to discourage change, or even to turn the clock back. It also discourages those blacks who are working for peaceful change, and makes more credible those who argue that change can only be brought about by violence. On the other hand, we should not delude ourselves that we have much leverage in the opposite direction—positive pronouncements about our desire for change in South Africa will not by themselves change the minds of those in the white government nor be seen as adequate by blacks of all persuasions who are seeking rapid change.

Likewise, it is doubtful that increased economic pressure on South Africa would speed change. In fact, it is easier to make a counter argument. If investment and growth are slowed, the need to incorporate blacks into skilled jobs decreases, and with that decrease the interest (and financial resources) to improve education and housing and to liberalize union rules also declines. Much of the Afrikaner population would be quite willing to hunker down and maintain a static economy—it is more predominantly the Anglo business community that presses for an expanding economy, with its concomitant social change. Most forms of economic sanctions would undercut precisely that part of the white population which is committed to change and the internal economic and social forces which are likely to lead to that change.

The analysis in this paper argues that disruptions in our supply of minerals are most likely to come about if change is violent, and if the form of government which ultimately controls South Africa is unable or unwilling to take the measures necessary to retain skilled workers and professionals and to encourage production and investment. These conditions are more likely to occur the longer change is prevented and the more black advocates of change see the Western world in general and the United States in particular as being disinterested in such change.

This would suggest that the United States should continue to seek a settlement in Namibia and the economic success of Zimbabwe and keep our relations correct but necessarily distant from the current government in South Africa. It suggests that economic sanctions, or even discouragement of U.S. investment in South Africa, is probably not productive, but that symbolic actions to indicate our disapproval of the apartheid system should be sought rather than avoided. It probably means that, as in the case of Zimbabwe, we should conduct programs which educate black South Africans in the United States or elsewhere in the Western world, who are unable or unwilling to receive higher education in their own country, so that there is a cadre of black South Africans available for future employment in South Africa who are familiar with U.S. values and institutions, and who one day can take their place as professional and social equals in a multiracial South African society. The United States may also want to consider appropriate programs to assist the education of blacks within South Africa. Such programs would, of course, run the risk that the United States might be perceived to be acquiescing in the current apartheid-dominated educational system—a risk which would have to be minimized or offset through careful designing of any programs undertaken by the U.S. Government. Education is one area (employment and politics are others) in which the United States should promote meaningful change leading to the rightful participation by blacks in the country's managerial and decisionmaking processes.

APPENDIX

TABLE I.—EUROPEAN MINERALS IMPORT DEPENDENCE

Raw material	European Community import dependence (percent)
Chrome	About 85 (with allowance for steel scrap).
Cobalt	100.
Manganese	100.
Platinum	About 90.
Vanadium	About 98.

Raw material	Import dependence (percent)					
	Germany	France	United Kingdom	Italy	Netherlands	Belux
Chrome	96	96	98	96	100	96
Manganese	98	98	98	90	100	98
Platinum	90	90	90	75	90	90
Vanadium	98	98	100	100	100	98

Raw material	Principal suppliers of EC (percent share)	
	Country	Percent share
Chrome	South Africa	50 (ore).
	South Africa	49 (ferro-chrome).
	Turkey	14 (ore).
	Turkey	3 (ferro-chrome).
Manganese	South Africa	45 (ore).
	Gabon	20 (ore).
	Norway	46 (ferro-manganese).
	South Africa	25 plus (ferro-manganese).
	South Africa	78 (metal).
Platinum	South Africa	28.
	U.S.S.R	24.
	Switzerland	23.
Vanadium	South Africa	25.
	Finland	23.
	Australia	18.
	Austria	55 (ferro-vanadium).
	Norway	26 (ferro-vanadium).

Source: Adapted from P.C.F. Crowson, "Non-Fuels Minerals Data Base." Royal Institute of International Affairs, London, 1980; and Stephen Warnecke, "Southern Africa in Conflict, The Importance of Minerals from South Africa."

TABLE II.—U.S. CHROMITE IMPORTS

1980 dependence on foreign sources: 91 percent.

Percent of imports: Republic of South Africa 41 percent, U.S.S.R. 17 percent, Philippines 14 percent, Turkey 10 percent, Other 18 percent.

[Unit of measure: Thousand short tons]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	(1)	4,525	3,539	507	4,725
Inventory	(1)	(1)	(1)	3,905	3,397	3,282	2,590
Deficit or surplus	(1)	(1)	(1)	−620	−142	+2,775	−2,135
United States:							
Mine production	3	0.4	107	0	0	0	0
Number of producing mines	6	1	1	0	0	0	0
Old scrap recovery, metal content	10	23	56	43	58	38	50
Apparent consumption (reported)	600	980	1,220	1,600	1,400	880	970
Imports	700	1,300	1,400	1,500	1,400	1,300	1,000
Import reliance (percent) (for element)	90	89	90	92	89	91	91
Stocks	600	600	1,700	1,100	800	1,000	900
Ore reserves	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Production by area:							
China							
Japan		35	74	46	36	26	15
South Africa	180	547	851	1,038	1,573	2,288	3,764
U.S.S.R.		550	1,010	1,565	1,930	2,290	2,700
North America (includes United States)	3		107				
Latin America (includes Mexico)	63	73	39	19	30	239	426
Western Europe	142	140	149	144	207	406	261
Eastern Europe	22		319	342	516	859	1,190
Other Africa	293	329	674	681	596	881	804
Other Asia	466	800	1,583	1,466	1,784	2,145	1,551
Australia and Oceania	61	94	44			2	14
World production total	1,230	3,948	4,850	5,301	6,672	9,136	10,725
World reserves (billions of short tons)	1.5	2.0	2.7	2.7	2.7	1.9	3.7
Number of producing countries	16	16	20	19	17	19	20

[1] Unavailable.
[2] Minor.

TABLE III.—U.S. FERROCHROMIUM IMPORTS

1980 dependence on foreign sources: 91 percent.
Percent of imports: Republic of South Africa 75 percent, Yugoslavia 7 percent, Zimbabwe 7 percent, Other 11 percent.

[Unit of measure: Thousand short tons]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	(1)	203	71	429	350
Inventory	(1)	(1)	(1)	258	279	280	759
Deficit or surplus	(1)	(1)	(1)	+55	+208	−149	+409
United States:							
Plant production	160	150	194	305	276	172	184
Number of producing plants	4	6	11	11	6	6	5
Old scrap recovery	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Apparent consumption (reported)	100	148	252	395	343	335	425
Imports	5	23	50	55	40	320	300
Import reliance (percent) (metal content)	90	89	90	92	89	91	91
Stocks	10	20	30	35	80	70	60
Ore reserves	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Production by area:							
China	(1)	(1)	(1)	50	60	60	100
Japan	(1)	3	87	129	399	536	471
South Africa	(1)	6	55	85	105	329	623
U.S.S.R.	(1)	81	131	400	500	700	770
North America (includes United States)	(1)	150	194	384	406	197	239
Latin America (includes Mexico)	(1)	.....	1	3	8	58	107
Western Europe	(1)	131	364	265	322	481	574
Eastern Europe	(1)	3	13	75	100	110	105
Other Africa	(1)	.....	.....	33	110	200	220
Other Asia	(1)	.....	.....	8	20	21	54
Australia and Oceania	(1)	35	62	1	2	.....	.....
World production total	(1)	409	907	1,433	2,032	2,692	3,263
World reserves	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Number of producing countries	(1)	12	14	19	21	20	21

[1] Unavailable.
[2] Not applicable.

TABLE VI.—FACT SHEET ON CHROMIUM

(Data in thousand short tons gross weight, unless noted)

Domestic production and use.—There was no domestic mine production of chromite in 1981. However, the United States continued to be one of the world's leading consumers. Chromite was consumed by seven firms producing chromium ferroalloys and metal; seven firms producing refractories; and three firms producing chromium chemicals. Most of these were in the Eastern United States. The metallurgical industry used 57 percent, chemical industry 25 percent, and the refractory industry 18 percent. Consumption of chromium by end use was as

follows: Construction, 19 percent; machinery and equipment, 17 percent; transportation, 12 percent; refractories, 12 percent; and all other uses 40 percent.

	1977	1978	1979	1980	1981
Salient statistics—United States:					
Production: Chromite [1]					
Imports for consumption: Chromite	1,336	1,013	1,024	982	890
Chromium ferroalloys [2]	228	322	243	297	315
Exports and reexports: Chromite	248	52	55	50	45
Chromium ferroalloys	12	19	15	32	15
Shipments from Government stockpile excesses: Chromite	517				
Consumption (reported): Chromite	1,000	1,010	1,209	968	940
Chromium ferroalloys	453	500	543	424	490
Consumption of chromium (apparent) [3]	570	590	610	539	481
Price (yearend):					
Chromite—Turkish, per metric ton, Turkey	$137	$105	$110	$110	$110
Chromite—South African, per metric ton, South Africa	$59	$56	$56	$55	$55
Consumer stocks: Chromite, yearend	1,338	1,301	907	675	725
Net import reliance [4] as a percent of apparent consumption	91	91	90	91	90

[1] Chromite ore is typically from 22 percent to 38 percent chromium content.
[2] Chromium ferroalloys are typically from 36 percent to 70 percent chromium content.
[3] Calculated total demand for chromium.
[4] Net import reliance equals imports minus exports plus adjustments for Government and industry stock changes.

Recycling.—In 1981, estimated recycled chromium contained in purchased stainless steel scrap amounted to 10 percent of total chromium demand.

Import sources (1977–80).—Chromite: Republic of South Africa 44 percent, Philippines 16 percent, U.S.S.R. 15 percent, Finland 9 percent, Other 16 percent. Ferrochromium: Republic of South Africa 71 percent, Yugoslavia 11 percent, Zimbabwe 7 percent, Sweden 4 percent, Other 7 percent.

Tariff item	Number	Most favored nation (MFN)		Non-MFN Jan. 1982
		Jan. 1982	Jan. 1987	
Ore and concentrate	601.15	Free	Free	Free.
Low-carbon ferrochromium	606.22	4 percent ad val.	3.1 percent ad val.	30 percent ad val.
High-carbon ferrochromium	606.24	0.625¢/lb. chromium [1]	0.625¢/lb. chromium	25 percent ad val.

[1] Until Nov. 15, 1982, 4.625¢ lb. on a material valued less than 38¢ lb. of chromium.

Depletion allowance.—22 percent (domestic), 14 percent (foreign).

Government programs.—Bureau of Mines research was being conducted on recovery of chromium from laterites and low-grade ores. Other Bureau studies concerned the development of chromium-free and low chromium alloys as substitutes for stainless steel, reclamation of chromium from stainless steel, recovery of chromium values from metallurgical and mining wastes and appraisal of chromite resources in Alaska and northwestern United States.

Material	Stockpile status—Nov. 30, 1981			
	Goal	Total inventory	Authorized for disposal	Sales, 11 mo
Chromite:				
Metallurgical-grade	3,200	1,957		
Chemical-grade	675	242		
Refractory-grade	850	391		
Chromium ferroalloys	350	759		
Chromium metal	20	4		

In addition to data shown, the stockpile contained the following nonstockpile-grade materials: 531,219 tons of metallurgical-grade chromite and 20,762 tons of chromium ferroalloys.

Events, trends and issues.—Demand for chromium in 1981 dropped to its lowest level since 1975, reflecting continued weak demand in the steel industry, the major consumer of chromium. Compared to 1980, consumption decreased in the metallurgical and refractory industries 15 percent and 20 percent, respectively, while the chemical industry consumption increased 5 percent.

The Committee of High-Carbon Ferrochromium Producers petitioned the International Trade Commission (ITC) in May for an extension of three additional years of the floor price and 4-cent per pound penalty duty on high-carbon ferrochromium entering the United States below a specified floor price. Both were due to expire in November 1981. After hearings were held in July, the ITC determined that high-carbon ferrochromium imports represented a substantial cause of threat of serious injury to domestic producers. ITC forwarded their recommendations to the President for his decision. On November 15, the President announced his decision to extend the current import relief provisions on high-carbon ferrochromium for one additional year.

The published price of Turkish high-chromium chromite remained at $110 per metric ton while the price of Russian chromite continued to be suspended. South African high-iron chromite price in 1981 was $51–$55 per metric ton, unchanged from the 1980 price. Ferrochromium prices moved somewhat higher. Along with other major consuming countries, the United States will continue to rely on imports of chromium. From a 1978 base, demand for chromium is expected to increase at an annual rate of about 3.2 percent through 1990. It is estimated that in 1982 domestic mine production of chromite will be zero and United States apparent consumption of chromium will be 530,000 tons.

International relationships in the future may influence the United States supply-demand position, as they have in the past. Increasing ferrochromium imports of the last few years compete with the domestic ferrochromium industry.

Environmental requirements for cleaner air impose economic problems for some processors. Disposal of reclaimed dust and slag remains a problem.

	Mine production		Reserve base [1]
	1980	1981 [2]	
World chromite mine production and reserve base:			
United States			
Finland	193	180	28,000
Philippines	631	600	3,300
South Africa, Republic of	3,764	3,400	2,500,000
Turkey	440	410	5,500
Zimbabwe	611	580	1,100,000
Other market economy countries	1,144	1,030	14,300
Central economy countries	3,942	3,700	22,500
World total	10,725	9,900	3,700,000

[1] Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.
[2] Estimate.

World resources.—World resources total about 36 billion tons of shipping-grade chromite, sufficient to meet conceivable demand for centuries. Over 99 percent of these resources are in southern Africa; nearly 25 billion tons in the Republic of South Africa and over 11 billion tons in Zimbabwe. Although the rest of the world's resources are measured in millions of tons, they are small in comparison with those in Africa. Most of the United States chromium resources are in the Stillwater Complex in Montana and beach sands of Oregon. Renewal of substantial domestic chromite mining in the near future is doubtful.

Substitutes and alternates.—Some elements or materials may substitute for chromium in various end use applications, but cost consideration, performance standards, and customer appeal are major determining factors in use of chromium. Typical substitute possibilities are: Nickel, zinc, or cadmium for corrosion protection of iron and steel; aluminum and plastics for automotive decorative trim; nickel, cobalt, molybdenum, or vanadium for alloying iron and steel; titanium for chemical processing equipment; cadmium yellow pigment for protective coatings; and magnesite and ziecon refractories for some refractory products.

TABLE V.—U.S. MANGANESE ORE IMPORTS

1980 dependence on foreign sources: 98 percent.

Percent of imports: Republic of South Africa 30 percent, Australia 29 percent, Gabon 23 percent, Brazil 10 percent, Others 8 percent.

[Unit of measure: Thousand short tons]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	(1)	6,860	2,812	788	2,932
Inventory	(1)	(1)	(1)	11,750	9,206	3,605	2,826
Deficit or surplus	(1)	(1)	(1)	+4,890	+6,394	+2,817	−106
United States:							
Mine production	45	134	80	29	5		
Number of producing mines	51	15	5	2	1		
Old scrap recovery	None	None	None	None	None	None	None
Reported consumption	1,322	1,650	1,946	2,873	2,364	1,819	1,071
Imports	1,436	1,835	2,544	2,575	1,735	1,574	698
Import reliance (percent)	NA	83	93	94	95	98	98
Stocks	913	827	2,588	1,540	1,768	2,064	1,030
Ore reserves	(1)	(1)	1,000	Small	Small		
Production by area:							
China			1,320	1,102	1,100	1,100	1,750
Japan		148	357	334	298	174	85
South Africa	454	872	1,316	1,728	2,954	6,359	6,278
U.S.S.R.	3,100	1,650	6,473	8,351	7,541	9,324	11,300
North America (includes United States)	45	134	80	29	5		
Latin America (includes Mexico)	491	325	1,490	2,089	2,440	2,909	2,923
Western Europe	68	55	137	101	97	28	50
Eastern Europe	2		357	380	222	239	141
Other Africa	699	1,314	1,832	3,355	2,665	3,414	2,810
Other Asia	1,066	1,109	1,515	1,976	1,894	1,862	1,929
Australia and Oceania	14	23	82	192	871	1,765	2,162
World production total	5,939	5,630	14,959	19,557	20,087	27,174	29,429
World reserves	(1)	(1)	1,000,000	Large	Large	6,000,000	5,400,000
Number of producing countries	43	37	41	45	40	28	26

[1] Unavailable.

TABLE VI.—U.S. FERROMANGANESE IMPORTS

1980 dependence on foreign sources: 98 percent.
Percent of imports: Republic of South Africa 37 percent, France 36 percent, Mexico 7 percent, Other 20 percent.

[Unit of measure: Thousand short tons]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	(1)	545	645	211	439
Inventory	(1)	(1)	(1)	1,062	1,205	629	600
Deficit or surplus	(1)	(1)	(1)	+517	+560	+418	+161
United States:							
Plant production	515	720	843	1,148	835	576	189
Number of producing plants	11	14	20	18	14	11	7
Old scrap recovery	None	None	None	None	None	None	None
Reported consumption	(1)	775	800	1,041	1,001	882	789
Imports	10	110	120	257	291	397	606
Import reliance (percent)	(1)	83	93	94	95	98	98
Stocks	(1)	168	220	146	278	396	206
Ore reserves	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Production by area:							
China	(1)	(1)	(1)	180	190	200	375
Japan	(1)	(1)	(1)	221	444	716	669
South Africa	(1)	(1)	(1)	200	260	371	573
U.S.S.R.	(1)	(1)	(1)	1,010	1,067	1,300	1,450
North America (includes United States)	(1)	(1)	(1)	1,185	882	632	269
Latin America (includes Mexico)	(1)	(1)	(1)	83	126	207	331
Western Europe	(1)	(1)	(1)	1,144	1,325	1,556	1,699
Eastern Europe	(1)	(1)	(1)	235	310	425	413
Other Africa	(1)	(1)	(1)	.....	.....	.....	3
Other Asia	(1)	(1)	(1)	190	229	198	317
Australia and Oceania	(1)	(1)	(1)	45	47	43	106
World production total	(1)	(1)	(1)	4,493	4,880	5,648	6,205
World reserves	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Number of producing countries	(1)	(1)	(1)	27	26	29	32

[1] Unavailable.
[2] Not applicable.

TABLE VII.—FACT SHEET ON MANGANESE

[Data in thousand short tons, gross weight, unless noted]

Domestic production and use.—There was no domestic production of manganese ore, containing 35 percent or more manganese, in 1981. Most ore consumption was by approximately 30 firms scattered over the United States, but principally in the East. Much of this ore was converted to ferromanganese, the chief form in which the manganese is ultimately used in the production of steel, its major use. Most of the remainder was used in the production of pig iron, dry cell batteries, and in various chemical processes. Ultimate major end use distribution: Construction, 23 percent; transportation, 20 percent; machinery, 16 percent; other, 41 percent.

	1977	1978	1979	1980	1981[1]
Salient statistics—United States:					
Production: Mine [2]	None	None	None	None	None
Imports for consumption:					
Manganese ore [3]	931	548	500	698	550
Ferromanganese [4]	534	680	821	606	740
Shipments from Government stockpile excesses:					
Manganese ore [3]	821	632	607	366	315
Ferromanganese [4]					
Exports:					
Manganese ore [3]	138	200	58	53	80
Ferromanganese [4]	6	9	25	12	18
Reported consumption: [5]					
Manganese ore [3]	1,359	1,281	1,372	1,071	1,075
Ferromanganese [4]	886	985	976	789	885
Apparent consumption of manganese [6]	1,523	1,363	1,250	1,029	1,150
Price (low and high): 46 to 48 percent Mn, metallurgical ore, per L.T.U. cont. Mn, c.i.f. U.S. ports	$1.42–1.53	$1.38–1.42	$1.36–1.42	$1.38–1.75	$1.71–1.76
Stocks: Producer and consumer, yearend:					
Manganese ore [3]	1,626	1,173	1,098	1,030	870
Ferromanganese [4]	296	237	225	206	165
Employment: Mine and mill	None	None	None	None	None
Net import reliance [7] as a percent of apparent consumption	98	97	98	98	98

[1] Estimate.
[2] Excludes manganiferous ore containing less than 35 percent manganese, which accounts for approximately 2 percent of apparent consumption of manganese.
[3] Manganese ore typically ranges from 35 percent to 54 percent manganese content.
[4] Ferromanganese typically ranges from 74 percent to 95 manganese content.
[5] The sum of manganese ore consumption and ferromanganese consumption can not be used as total manganese consumption, because much of the ore is consumed to produce ferromanganese.
[6] Thousand short tons, manganese content (elemental manganese). Based on estimates of average content for all significant components except imports which are reported content.
[7] Net import reliance equals imports minus exports plus adjustments for Government and industry stock changes.

Recycling.—Not significant.

Import sources—United States (1977–80):

Manganese ore [2]—Gabon 40 percent, Brazil 19 percent, Australia 15 percent, Republic of South Africa 14 percent, Other 12 percent.

Ferromanganese [3]—Republic of South Africa 39 percent, France 25 percent, Other 36 percent.

Tariff item	Number	Most favored nation (MFN)		Non-MEN Jan. 1, 1982
		Jan. 1, 1982	Jan. 1, 1987	
Ore and concentrate	601.27	Free	Free	1¢/lb. of contained Mn.
Metal	632.30	14 percent ad val.	14 percent ad val.	20 percent ad val.
High carbon ferromanganese	606.30	1.6 percent ad val.[1]	1.5 percent ad val.	10.5 percent ad val.

[1] Free from certain countries under generalized system of preferences.

[2] Manganese ore typically ranges from 35 percent to 54 percent manganese content.
[3] Ferromanganese typically ranges from 74 percent to 95 percent manganese content.

Depletion allowance.—22 percent (domestic), 14 percent (foreign).
Government Programs:

Material	Stockpile status—Nov. 30, 1981			
	Goal	Total inventory	Authorized for disposal	Sales, 11 mo
Battery:				
Natural ore	62	185	45	10
Synthetic dioxide	25	3		
Chemical ore	170	221	51	
Metalliurgical ore	2,700	2,409		
Ferromanganese:				
High carbon	439	600		
Medium carbon		29		
Silicomanganese		24		
Electrolytic metal		14		

In addition to data shown, the stockpile contains 34,000 tons of natural battery ore and 961,000 tons of metallurgical ore, both of nonstockpile grade.

Events, trends and issues.—Ready availability worldwide of manganese for metallurgical purposes was evidenced by sluggish commodity markets. Further changes in ownership of domestic electric-furnace ferroalloy plant put U.S. production of manganese ferroalloys predominantly under foreign control.

From a 1978 base, U.S. demand for manganese is expected at an annual rate of about 1.6 percent through 1990. It is estimated that in 1982 domestic mine production of manganese ore will be zero, and U.S. apparent consumption of manganese will be 1.2 million short tons, content basis U.S. demand will continue to be supplied primarily by imports except as it might be supplemented by deliveries of Government stockpile excesses. Extensive deposits of manganese nodules on the deep ocean floors continue under investigation by United States and foreign companies. In the continuing absence of a Law of the Sea Treaty, the U.S. Department of Commerce, as authorized by Public Law 96–283, published regulations under which 10-year licenses could be issued to eligible U.S. citizens for deep seabed exploration.

Manganese is an essential element for man and animals. In excess, however, it can be harmful. Although manganese poisoning can be an industrial hazard, it is not ordinarily a hazard to the general population. Environmental effects of ocean mining are incompletely known, but investigative work to date suggests that they probably are not significant, at least during exploration. This work is continuing.

	Mine production		Reserve base [1]
	1980	1982 [2]	
World mine production and reserve base:			
United States			
Australia	2,162	2,200	330,000
Brazil	[2] 2,400	2,300	95,000
Gabon	2,366	1,800	159,000
India	1,814	1,800	50,000
South Africa, Republic of	6,278	6,600	2,200,000
Other market economy countries	[2] 1,218	1,100	63,000
U.S.S.R.	11,300	11,400	2,400,000
China, Mainland	[2] 1,750	1,700	50,000
Other central economy countries	[2] 141	100	25,000
World total [3]	[2] 29,000	29,000	5,400,000

[1] Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.
[2] Estimate.
[3] Data may not add to totals shown because of independent rounding.

World resources.—Identified land-based resources are very large but are irregularly distributed. The U.S.S.R. and the Republic of South Africa account for more than 80 percent of the world identified resources; the Republic of South Africa for more than 75 percent of those of the market economy countries. There are also very extensive deep-sea resources in the form of manganese oxide deposits over large areas of the ocean floors, particularly in the equatorial Pacific Ocean.

Substitutes and alternates.—There is no satisfactory substitute for manganese in its major applications.

TABLE VIII.—U.S. PLATINUM GROUP IMPORTS

1980 dependence on foreign sources: 88 percent.

Percent of imports: Republic of South Africa 54 percent, United Kingdom 14 percent, U.S.S.R. 11 percent.

[Unit of measure: Thousand troy ounces]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	590	509	1,767	1,872	3,862	4,408
Inventory	(1)	248	1,378	1,534	1,717	1,725	1,725
Deficit or surplus	(1)	−342	+869	−233	−155	−2,137	−2,683
United States:							
Mine production	42	38	20	38	20	19	3
Number of producing mines	1	1	1	1	1	1	0
Old scrap recovery	66	58	77	109	350	270	331
Apparent consumption	207	364	690	1,111	1,681	1,737	2,859
Imports	196	428	681	1,193	1,532	1,820	3,502
Import reliance (percent)	NA	74	86	87	78	83	88
Stocks	270	267	516	926	765	849	973
Ore reserves (metal content)	(1)	(1)	(1)	50	3,000	1,000	1,000
Production by area:							
China							
Japan			2	5	8	19	43
South Africa	72	100	406	754	1,503	2,600	3,100
U.S.S.R.	100	151	330	1,700	2,200	2,650	3,250
North America (includes United States)	241	162	507	498	500	418	408
Latin America (includes Mexico)	36	26	29	11	26	22	13
Western Europe	1			1	1	7	7
Eastern Europe							
Other Africa	6						
Other Asia					1	1	
Australia and Oceania						2	10
World production total	456	439	1,274	2,969	4,239	5,719	6,831
World reserves (metal content)	(1)	(1)	(1)	40,000	424,000	561,000	1,180,000
Number of producing countries	7	5	6	6	8	9	9

1 Unavailable.

TABLE IX.—U.S. PLATINUM IMPORTS

1980 dependence on foreign sources: 87 percent.
Percent of imports: Republic of South Africa 74 percent, United Kingdom 15 percent, Canada 2 percent.

[Unit of measure: Troy ounces]

	1940	1950	1960	1965	1970	1975	1980
National stockplie:							
Objective	(1)	(1)	165,000	450,000	555,000	1,314,000	1,310,000
Inventory	(1)	(1)	(1)	766,000	450,035	452,645	452,640
Deficit or surplus	(1)	(1)	(1)	+316,000	−104,965	−861,355	−857,360
United States:							
Mine production	8,000	13,000	10,000	10,000	8,000	6,000	1,000
Number of producing mines	1	1	1	1	1	1	0
Old scrap recovery	48,000	34,000	39,000	54,000	118,000	104,000	154,000
Apparent consumption	190,000	289,000	268,000	368,000	509,000	874,000	1,204,000
Imports	127,000	249,000	238,000	387,000	540,000	980,000	1,615,000
Import reliance (percent)	(1)	84	82	83	75	87	87
Stocks	144,000	125,000	261,000	389 000	292,000	421,000	502,000
Ore reserves (metal content)	(1)	(1)	(1)	<50,000	<3,000,000	<1,000,000	<1,000,000
Production by area:							
China	(1)	(1)	(1)	0	0	0	0
Japan	(1)	(1)	(1)	2,466	3,296	5,486	12,900
South Africa	(1)	(1)	(1)	465,000	930,000	1,612,000	1,891,000
U.S.S.R	(1)	(1)	(1)	510,000	660,000	795,000	812,000
North Amercia (includes United States)	(1)	(1)	(1)	210,287	216,467	179,068	162,000
Latin America (includes Mexico)	(1)	(1)	(1)	10,317	24,408	20,500	12,000
Western Europe	(1)	(1)	(1)	0	320	300	300
Eastern Europe	(1)	(1)	(1)	0	0	0	700
Other Africa	(1)	(1)	(1)	353	273	162	120
Other Asia	(1)	(1)	(1)	0	352	579	0
Australia and Oceania	(1)	(1)	(1)	0	0	430	2,500
World production total	(1)	(1)	(1)	1,198,423	1,835,116	2,613,525	2,893,520
World reserves (metal content)	(1)	15,000,000	15,000,000	(1)	225,000,000	297,000,000	520,000,000
Number of producing countries	(1)	(1)	(1)	7	9	10	10

[1] Unavailable.

TABLE X.—U.S. PALLADIUM IMPORTS

1980 dependence on foreign sources: 90 percent.
Percent of imports: Republic of South Africa 49 percent, U.S.S.R. 26 percent, United Kingdom 12 percent.

[Unit of measure: Troy ounces]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	340,000	1,300,000	1,300,000	2,450,000	3,000,000
Inventory	(1)	(1)	(1)	738,000	1,249,832	1,254,994	1,255,003
Deficit or surplus	(1)	(1)	(1)	−562,000	−50,168	−1,195,006	−1,744,997
United States:							
Mine production	5,000	19,000	14,000	21,000	10,000	13,000	2,000
Number of producing mines	1	1	1	1	1	1	0
Old scrap recovery	15,000	21,000	35,000	50,000	209,000	150,000	162,000
Apparent consumption	79,000	150,000	371,000	676,000	1,306,000	580,000	1,483,000
Imports	60,000	147,000	368,000	741,000	811,000	573,000	1,619,000
Import reliance (percent)	(1)	(1)	87	89	83	72	90
Stocks	93,000	108,000	204,000	427,000	333,00	336,000	353,000
Ore reserves (metal content)	(1)	(1)	(1)	<50,000	<3,000,000	<1,000,000	<1,000,000
Production by area:							
China	(1)	(1)	(1)	0	0	0	0
Japan	(1)	(1)	(1)	2,952	4,610	13,915	29,700
South Africa	(1)	(1)	(1)	187,500	375,000	650,000	806,000
U.S.S.R	(1)	(1)	(1)	1,020,000	1,320,000	1,590,000	2,178,000
North America (includes United States)	(1)	(1)	(1)	205,731	216,134	184,047	186,000
Latin America (includes Mexico)	(1)	(1)	(1)	89	211	200	100
Western Europe	(1)	(1)	(1)	0	320	300	300
Eastern Europe	(1)	(1)	(1)	0	0	0	5,300
Other Africa	(1)	(1)	(1)	353	273	0	0
Other Asia	(1)	(1)	(1)	0	878	836	0
Australia and Oceania	(1)	(1)	(1)	0	0	1,400	7,200
World production total	(1)	(1)	(1)	1,416,625	1,917,426	2,440,698	3,212,600
World reserves (metal content)	(1)	7,500,000	7,500,000	(1)	148,000,000	194,000,000	434,000,000
Number of producing countries	(1)	(1)	(1)	7	9	9	9

[1] Unavailable.

TABLE XI.—U.S. IRIDIUM IMPORTS

1980 dependence on foreign sources: 88 percent.
Percent of imports: Republic of South Africa 50 percent, United Kingdom 28 percent, West Germany 5 percent.

[Unit of measure: Troy ounces]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	4,000	17,000	17,000	97,761	98,000
Inventory	(1)	(1)	(1)	14,000	17,256	17,002	16,991
Deficit or surplus	(1)	(1)	(1)	−3,000	+256	−80,759	−81,009
United States:							
Mine production	1,000	(1)	(1)	(1)	1,000	0	0
Number of producing mines	1	1	1	1	1	0	0
Old scrap recovery	1,000	1,000	900	1,000	2,000	2,000	3,000
Apparent consumption	19,000	NA	0,000	10,000	8,000	15,000	24,000
Imports	200	7,000	4,000	7,000	11,000	21,000	44,000
Import reliance (percent)	(1)	(1)	(1)	(1)	62	87	88
Stocks	32,000	(1)	11,000	18,000	16,000	18,000	15,000
Ore reserves (metal content)	None	None	None	None	None	None	None
Production by area:							
China	(1)	(1)	(1)	0	0	0	0
Japan	(1)	(1)	(1)	0	0	0	0
South Africa	(1)	(1)	(1)	11,660	20,900	33,800	31,000
U.S.S.R.	(1)	(1)	(1)	34,000	44,000	53,000	65,000
North America (includes United States)	(1)	(1)	(1)	10,189	11,000	8,943	8,000
Latin America (includes Mexico)	(1)	(1)	(1)	357	843	700	400
Western Europe	(1)	(1)	(1)	0	0	0	0
Eastern Europe	(1)	(1)	(1)	0	0	0	0
Other Africa	(1)	(1)	(1)	0	0	0	0
Other Asia	(1)	(1)	(1)	0	0	0	0
Australia and Oceania	(1)	(1)	(1)	0	0	0	0
World production total	(1)	(1)	(1)	56,206	76,743	96,443	104,400
World reserves	(1)	2,500,000	2,500,000	(1)	6,000,000	8,000,000	17,000,000
Number of producing countries	(1)	(1)	(1)	5	5	4	4

[1] Unavailable.

TABLE XII.—FACT SHEET ON PLATINUM GROUP

[Platinum, palladium, iridium, osmium, rhodium, ruthenium; data in thousand troy ounces, unless noted]

Domestic production and use.—Domestic primary production was derived partly as a byproduct of copper refining by three firms; and partly from placer deposits in Alaska by a single firm. Output was valued at about $1.4 million. Secondary metal was refined by about 30 firms, most in the East and Midwest. The platinum-group metals were sold by at least 90 processors and retailers, largely in the Northeast, and were distributed among using industries as follows: Automotive, 30 percent; electrical, 26 percent; chemical, 14 percent; dental, 12 percent; and other, 18 percent. The automotive, chemical, and petroleum refining industries

used the platinum-group metals mainly as catalyst; other industries used the metals in a variety of ways that took advantage of their chemical inertness and refractoriness.

	1977	1978	1979	1980	1981[1]
Salient statistics—United States:					
Production: Mine	6	8	7	3	6
Refinery:					
New	5	8	8	2	6
Secondary	195	257	309	331	350
Imports for consumption	2,510	2,921	3,479	3,502	3,000
Exports	427	703	900	765	975
Shipments from Govt. stockpile excesses	None	None	None	None	None
Consumption (reported sales to industry)	1,592	2,260	2,756	2,206	2,000
Apparent consumption	2,357	2,635	2,995	2,859	2,356
Price (dollars per ounce): [2]					
Platinum (average)	162	237	352	439	475
Palladium (average)	60	71	113	214	150
Stocks, yearend (refiner, importer and dealer)	1,013	861	761	973	1,000
Employment: Refinery [1]	350	350	375	400	400
Net import reliance [3] as a percent of apparent consumption	91	90	89	88	85

[1] Estimate.
[2] Producer price.
[3] Net import reliance equals imports minus exports plus adjustments for Government and industry stock changes.

Recycling.—In 1981, about 350,000 ounces of platinum-group metals were refined from scrap on a non-toll basis, an amount equivalent to 18 percent of sales to industry. The quantity of toll-refined secondary was much larger, amounting to more than 1 million ounces. The proportion of new scrap to old scrap was not known.

Import sources (1977–80).—Republic of South Africa 55 percent, U.S.S.R. 18 percent, United Kingdom 11 percent, Other 16 percent.

Tariff item	Number	Most favored nation (MFN)		Non-MFN Jan. 1, 1982
		Jan. 1, 1982	Jan. 1, 1987	
Ore	601.39	Free	Free	Free.
Platinum-group metals	605.02, 605.07	Free	Free	Free.
Alloys	605.03, 605.08	15.6 percent ad valorem	8.2 percent ad valorem	65 percent ad valorem.
Scrap	605.70	Free	Free	Free.

Depletion allowance.—22 percent (domestic), 14 percent (foreign).

Government programs.—The Bureau of Mines conducted research on the processing of domestic platinum-group metals ores, on recovery from electronic scrap, and on electrodeposition of platinum-group metals coatings. Automobile emission standards for 1982 models remained unchanged from those set for 1981 models. At the same time, the Environmental Protection Agency granted waivers on some pollution standards for certain 1982 model automobiles.

Material	Stockpile status—Nov. 30, 1981			
	Goal	Total inventory	Authorized for disposal	Sales, 11 mo
Platinum	1,310	453		
Palladium	3,000	1,253		
Iridium	98	17		

In addition to data shown, the stockpile contains 13,000 troy ounces of platinum and 2,000 troy ounces of palladium nonstockpile grade material.

Events, trends, and issues.—In 1981, world production of platinum-group metals was about 6.8 million troy ounces, essentially unchanged from that of 1980. The Republic of South Africa and the U.S.S.R. accounted for 94 percent of the world total.

Sales of platinum-group metals to U.S. industries dropped 9 percent in 1981 to about 2.0 million ounces. Catalysts in automobile exhaust converters was again the largest single end use. It is estimated that in 1982 domestic mine production of platinum will be 6,000 ounces and U.S. apparent consumption will be 2.4 million ounces. From a 1978 base, demand in the United States is expected to increase at an annual rate of about 1.5 percent through 1990.

Imports, which account for essentially all of the annual U.S. requirement for primary platinum-group metals, dropped 14 percent, to about 3.0 million ounces. The Republic of South Africa was the most important source, followed by the United Kingdom (which has no mine production, but is an important processor of concentrates imported from the Republic of South Africa and Canada), and the U.S.S.R.

Dealers' prices for platinum and palladium, as reported in Metals Week, declined sharply in 1981. Both metals were at their highest price levels in the first week of January (platinum $565 per ounce and palladium $142 per ounce). Starting in February, the platinum dealers' price ranged between $400 per ounce and $500 per ounce for most of the year. In March, the platinum dealers' price briefly increased to $538 per ounce, and in August, briefly decreased to $398 per ounce. The palladium dealers' price declined below $100 per ounce in June. By October, both the platinum and palladium dealers' price were well below the producers' prices. The platinum producers' price remained at $475 per ounce through the year, but the palladium producers' price decreased from $200 per ounce to $140 per ounce on February 20, and then decreased again to $110 per ounce on May 28.

Exploration and evaluation of the platinum-group metal resources in the Stillwater Complex, Montana, currently the only U.S. deposit where significant production of these metals is possible, continued. Although U.S. deposits may be developed, it is unlikely that domestic production could satisfy domestic demand. Environmental factors concerning present domestic production are those associated with copper production.

	Mine production		Reserve base [1]
	1980	1981 [2]	
World mine production and reserve base:			
United States	3	6	16,000
Canada	405	350	9,000
South Africa, Republic of	3,100	3,100	970,000
Other market economy countries	72	74	NA
U.S.S.R.	3,250	3,250	200,000
World total	6,830	6,780	1,195,000

[1] Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.
[2] Estimate.

World resources.—World resources of the platinum-group metals are estimated to be about 3.2 billion troy ounces, 2.7 times the estimated reserves, and more than 20 times the forecast demands for primary metal in the period 1981–2000. Total U.S. resources are estimated at about 300 million troy ounces, most of which occur in Montana and Minnesota.

Substitutes and alternates.—Potential substitutes are gold, silver, and tungsten in electrical and electronic uses; gold in dental uses; metals, such as the rare-earth elements, nickel, vanadium, and titanium, and molecular sieves, in catalytic uses. New and/or improved engines and fuels, and electric automobiles, could reduce the use of platinum-group metals in emission control catalysts in automobiles.

TABLE XIII.—U.S. VANADIUM IMPORTS

1980 dependence on foreign sources: 17 percent.
Percent of imports: Republic of South Africa 62 percent, Finland 19 percent, Canada 9 percent, Other 10 percent.

[Unit of measure: Short tons of contained vanadium]

	1940	1950	1960	1965	1970	1975	1980
National stockpile:							
Objective	(1)	(1)	(1)	1,400	540	540	8,700
Inventory	(1)	(1)	(1)	7,865	3,345	540	543
Deficit or surplus	(1)	(1)	(1)	+6,465	+2,805	0	−8,157
United States:							
Mine production	1,081	2,298	4,971	5,226	5,319	4,743	4,806
Number of producing mines	(1)	(1)	(1)	(1)	(1)	64	101
Mill production	774	1,821	5,495	6,160	5,594	4,859	5,506
Number of operating mills	(1)	(1)	6	6	5	4	6
Apparent consumption	(1)	2,399	2,223	7,208	7,066	7,858	6,607
Imports	1,287	762	10	18	2,024	4,236	2,974
Import reliance (percent)	(1)	4	0	15	21	38	17
Stocks	(1)	(1)	(1)	2,217	4,011	4,516	4,144
Ore reserves	(1)	(1)	(1)	680,000	115,000	115,000	115,000
Production by area:							
China							5,000
Japan							
South Africa			656	1,519	7,127	11,734	14,000
U.S.S.R.					3,800	8,800	11,000
North America (includes United States)	1,081	2,298	4,971	5,226	5,319	4,743	4,806
Latin America (includes Mexico)	1,375	482		1	610	660	400
Western Europe			625	1,813	2,640	1,915	3,700
Eastern Europe							
Other Africa	877	325	984	1,275	443	619	
Other Asia							
Australia and Oceania							650
World production total	3,333	3,105	7,236	9,834	19,939	28,471	39,556
World reserves (million short tons)	(1)	(1)	(1)	(1)	10.1	10.7	20.4
Number of producing countries	5	5	5	5	8	7	8

[1] Unavailable.

TABLE XIV.—FACT SHEET ON VANADIUM

[Data in thousand pounds vanadium content, unless noted]

Domestic production and use.—Five firms produced vanadium oxides in 1981 from domestic materials that included Colorado Plateau uranium-vanadium ores and sludges, Arkansas vanadium ore, and Idaho ferrophosphorus slags. Four other firms produced oxides and/or ferrovanadium from petroleum residues, utility ashes, spent catalysts, and imported iron slags. Mill production was valued at an estimated $76 million. The chief use of vanadium was as an alloying agent for iron and steel. It was also important in the production of titanium alloys, and as a catalyst for production of sulfuric acid. About 210 plants throughout the

United States reported consumption in 1981. Major end use distribution: Transportation, 35 percent; construction, 27 percent; machinery, 25 percent; chemicals, 4 percent; and other, 9 percent.

	1977	1978	1979	1980	1981 [1]
Salient statistics—United States:					
Production:					
Mine (recoverable basis)	13,008	8,544	11,040	9,612	10,600
Mill (recovered basis) [2]	10,416	10,409	11,517	11,012	12,100
Imports for consumption:					
Ores, slags, residues	5,624	4,468	4,883	3,572	5,300
Vanadium pentoxide (anhydride)	896	1,478	1,814	1,711	890
Ferrovanadium	673	782	1,033	525	2,100
Exports: [3]					
Vanadium pentoxide (anhydride)	384	1,388	706	811	440
Other compounds plus ores		731	581	320	150
Ferrovanadium	658	1,309	1,231	1,123	750
Shipments from Government stockpile excesses					
Consumption (intermediate products), reported	10,522	13,260	13,438	12,278	14,600
Consumption, apparent [4]	16,038	16,328	16,063	13,214	20,700
Price (average, per pound V_2O_5)	$2.95	$3.17	$3.39	$3.54	$3.52
Stocks: Producer and consumer, yearend	8,726	6,106	6,806	8,288	6,800
Employment	(6)	(6)	(6)	(6)	(6)
Net import reliance [5] as a percent of apparent consumption	35	36	28	17	42

[1] Estimate.
[2] Produced from domestic materials.
[3] Effective Jan. 1, 1978, vanadium export classifications were not directly comparable with earlier years because of changes in statistical classifications of the Bureau of the Census, U.S. Department of Commerce.
[4] Includes processing losses from low-grade imports.
[5] Net import reliance equals imports minus exports plus adjustments for Government and industry stock changes.
[6] Not available.

***Recycling.*—Relatively small quantities of spent catalysts containing vanadium were reprocessed. Some tool steel scrap was recycled primarily for its vanadium content. Vanadium was also recycled as a minor component of scrap iron and steel alloys, which were used principally for their iron content.**

***Import sources (1977–80).*—Republic of South Africa 58 percent, Chile 16 percent, Canada 7 percent, Other 19 percent.**

Tariff item	Number	Most favored nation (MFN)		Non-MFN Jan. 1, 1982
		Jan. 1, 1982	Jan. 1, 1987	
Ore and concentrate	601.60	Free	Free	Free.
Vanadium-bearing materials (slags and residues).	603.65	Free	Free	Free.
Ferrovanadium	606.50	5.7 percent ad val.	4.2 percent ad val.	25 percent ad val.
Metal, unwrought, and waste and scrap.	632.58	4.5 percent ad val.	3.7 percent ad val.	25 percent ad val.
Ammonium vanadate	417.42	14.2 percent ad val.	11.2 percent ad val.	40 percent ad val.
Vanadium carbide	422.58	5.3 percent ad val.	4.2 percent ad val.	25 percent ad val.
Vanadium pentoxide (anhydride)	422.60	16 percent ad val.	16 percent ad val.	40 percent ad val.
Vanadium compounds, other	422.62	16 percent ad val.	16 percent ad val.	40 percent ad val.
Vanadium salts of organic acids	427.22	13.9 percent ad val.	13.9 percent ad val.	40 percent ad val.

Depletion allowance.—22 percent (domestic), 14 percent (foreign).

Government programs.—Bureau of Mines research included investigations to improve vanadium recovery from low-grade ores and a study of the environmental effects of using high vanadium fossil fuels. The General Services Administration sought to acquire 1.8 million pounds (gross weight) of vanadium pentoxide for the National Defense Stockpile.

Material	Stockpile status—Nov. 30, 1981			
	Goal	Total inventory	Authorized for disposal	Sales, 11 mo
Vanadium pentoxide	15,400	1,082		
Ferrovanadium	2,000			

Events, trends, and issues.—Consumption of vanadium increased in 1981, primarily because of improved activity in the steel industry. In the future, consumption of vanadium should grow with increased demand for high performance materials and especially for high-strength low-alloy steels. Weight savings obtained by the use of these steels are particularly attractive in the transportation industry. It is estimated that in 1982 domestic mine production of vanadium will be 11 million pounds on the recoverable basis, and U.S. apparent consumption will be 19 million pounds. From a 1978 base, demand for vanadium is expected to increase at an annual rate of about 4 percent through 1990.

In 1981, mining operations on the Colorado Plateau were hurt by the continuing weak demand for uranium oxide. A new uranium-vanadium mill became fully operational in Utah, but two other facilities in Colorado were shut down for a large part of the year. Byproduct vanadium continued to be recovered from ashes of Caribbean oils burned at power-generating facilities. Shipments of vanadium pentoxide started at one of two active mine projects in Western Australia. China increased its efforts to market vanadium materials which are a byproduct of its iron and steel industry.

Environmental pollution problems included radon daughter exposure in underground uranium-vanadium mines, disposal of wastes as ponded liquids and fine tailings, and toxicity of certain vanadium materials. Modern technology aided the industry in controlling these problems.

	Production [1]		Reserve base [2]
	1980	1981	
World mine production and reserve base:			
United States	9,612	10,600	230,000
Australia	1,300	1,300	780,000
Finland	6,200	5,400	280,000
South Africa, Republic of	28,000	24,000	17,200,000
Other Market Economy Countries	2,000	2,200	1,100,000
China, Mainland	10,000	11,000	5,200,000
U.S.S.R.	22,000	24,000	16,000,000
World total [3]	79,100	78,500	40,800,000

[1] Estimate.

[2] Pending establishment of criteria for the reserve base, classification of data is based on a judgmental appraisal of current knowledge and assumptions.

[3] Data may not add to totals shown because of independent rounding.

World resources.—World resources of vanadium exceed 120 billion pounds. Vanadium occurs in deposits of titaniferous magnetite, phosphate rock, and uraniferous sandstones and siltstones where it constitutes less than 2 percent of the host rock. Significant amounts are also present in bauxite and carboniferous materials such as crude oil, coal, oil shale, and tar sands. Because vanadium is generally recovered as a byproduct or coproduct, identified world resources of the element are not fully indicative of available supplies. While domestic resources are adequate to supply current domestic needs, a substantial part of U.S. demand is currently met by foreign material because of price advantages.

Substitutes and alternates.—Steels containing various combinations of other alloying metals can be substituted for steels containing vanadium. Among the various metals that are interchangeable to some degree with vanadium are columbium, molybdenum, manganese, titanium, and tungsten. Platinum may be used as a substitute for vanadium compounds as a catalyst in some chemical processes. The cost of these materials influences their usage.

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